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Re-description of *Opisthotropis laui* Yang, Sung and Chan, 2013 (Squamata: Natricidae)

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Abstract We provide an expanded morphological description of the rarely known Lau's stream snake *Opisthotropis laui* Yang, Sung and Chan, 2013 based on six new specimens from Qixingkeng Natural Reserve, Enping City and Mt. Nianyu, Shangchuan Island, Taishan City, Guangdong Province of China. The diagnostic characters of *O. laui* are revised accordingly as follows: dorsal scales moderately keeled throughout, in 23(25):23:21(23) rows; 10 supralabials; 9–11 infralabials; two internasals, longer than wide, not touching with the loreal; one loreal, not touching with the eye; one or two preoculars; two postoculars; one or two posterior temporal scales; 170–176 ventrals in males, 152–159 ventrals in females; 58-61 pairs of subcaudals in males, 53-61 in females; body and tail dark olive above, with light yellow cross bars.

Keywords *Opisthotropis laui*, morphology, re-description, range extension, China

1. Introduction

The genus *Opisthotropis* Günther, 1872 currently contains twenty-one recognized species with a widespread distribution throughout southern China and mainland of Southeast Asia, eastward to the Ryukyu Archipelago of Japan, and southward to Sumatra of Indonesia and the Philippines (Ziegler *et al.*, 2008; David *et al.*, 2011, 2015; Yang *et al.*, 2013; Teynié *et al.*, 2014). Most members of *Opisthotropis* are strictly nocturnal, inhabit flowing streams and occasionally dwell in riparian habitats (Yang *et al.*, 2013). Many species were described based on a single or a few specimens, and are still imperfectly known so far (Stuart and Chuaynkern 2007; Ziegler *et al.*, 2008; David *et al.*, 2011; Yang *et al.*, 2013; Teynié *et al.*, 2014).

The Lau's stream snake, *Opisthotropis laui* Yang, Sung and Chan 2013 was originally described based on a single female specimen with following diagnostic characters: dorsal scales weakly keeled throughout, in 25:23:23 rows; 10 supralabials; 11 infralabials; two internasals, longer than wide, not touching the loreal; one loreal, not touching the eye; one preocular; two postoculars; one anterior temporal scale; 152 ventrals; 53 subcaudals; body and tail dark olive above, with light yellow crossbars (Yang *et al.*, 2013). During recent herpetological surveys in southern China, six *Opisthotropis* specimens were collected from Qixingkeng Natural Reserve, Enping City and Mt. Nianyu, Shangchuan Island, Taishan City, Guangdong Province. The morphological characters of these six specimens basically match the diagnosis of *O. laui* in Yang *et al.*, (2013) by having dorsal scale rows in 23:23:21(23), dorsal surface dark olive with yellow cross bars, we therefore identified these newly collected specimens as *O. laui*. Herein, a detailed morphological description included sexual dimorphism, the revised diagnostic characters and ecology information, as well as the expanded geography range are provided.

2. Materials and Methods

2.1 Sampling SYS r001161 and 1070, adult males; SYS r001169 and 1171, adult females, from Mt. Nianyu (21°43′8.24″N, 112°44′21.14″E; 108 m a.s.l.), Shangchuan Island, Taishan City, Guangdong Province (Figure 1), were collected by Zhi-Tong Lyu, Hai-Long He and Jian Wang on 22nd April 2016; SYS r001623, adult

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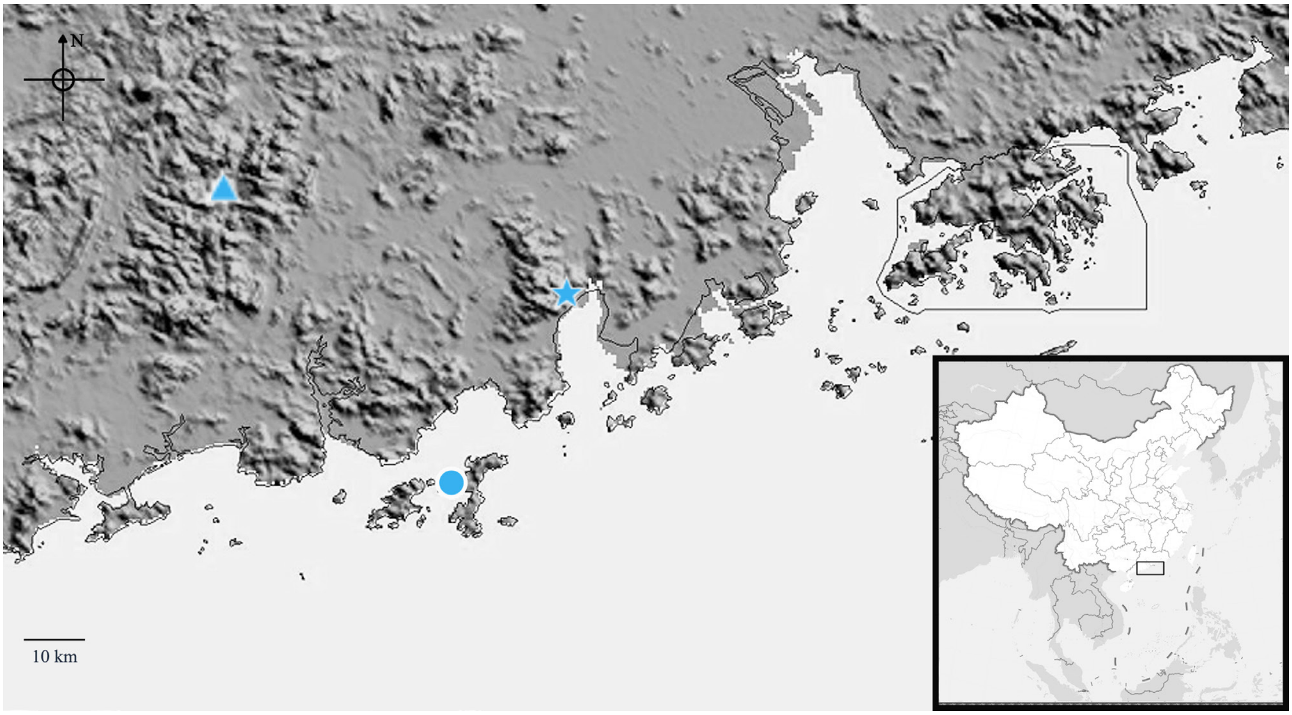

Figure 1 The known distributions of *Opisthotropis laui.* Solid star: type locality, Mt. Gudou, Jiangmen City, Guangdong Province; solid circle: Mt. Nianyu, Shangchuan Island, Taishan city, Guangdong Province; solid triangle: Qixingkeng Natural Reserve, Enping City, Guangdong Province, China.

male and SYS r001622, adult female from Qixingkeng Natural Reserve (22°20′51.64″N, 112°06′1.37″E; 230 m a.s.l.), Enping City, Guangdong Province, China (Figure 1), were collected by Can-Rong Lin, Zhao-Chi Zeng, Chun-Peng Guo and Jian Wang on 27th August 2016. All six specimens were initially fixed in 10% formalin, then transferred to 75% ethanol for preservation, and deposited at The Museum of Biology, Sun Yat-sen University, Guangzhou, China (SYS).

2.2 Morphological characters Measurements were taken with a digital caliper to the nearest 0.1 mm: total length (TL) from the tip of the snout to the tip of the tail; snout-vent length (SVL) from the tip of the snout to the anterior margin of the cloaca; tail length (TaL) from the posterior margin of the cloaca to the tip of the tail; head length (HL) from the tip of the snout to the posterior margin of the mandible; maximum head width (HW); snout length (SNL) from tip of snout to anterior corner of the eye; Scale counts were taken following to Yang *et al.*, (2013) as follows: internasals (IN); number of preoculars (PrO); number of postoculars (PtO); loreals (L); prefrontals (PrF); number of supralabials (SL); number of infralabials (IL); number of temporals; number of ventral scales (V, following Dowling 1951); number of subcaudals on one side except terminal spine (SC); dorsal scale rows (DSR) were counted at anterior neck (Sq1, at the level of the 15th ventral scale from the head), mid-body (Sq2, halfway between rear of head and opening of cloaca), and anterior to cloaca (Sq3, at the level of the 15th ventral scale anterior to the opening of the cloaca).

3. Results

3.1 Description of new specimens Body cylindrical, slightly small; TL 387.0–497.9 mm, SVL 312.0–391.4 mm; head small, indistinct from neck, HL 13.1–16.2 mm, HW 7.9–10 mm, SE 3.6–4.7 mm; tail short, TaL 75.0–106.5 mm, 19.4–21.4% of TL; eye small, ED 1.2–1.7mm, 9%–10.7% of HL; pupil round; rostral narrow, just visible from above, two times as broad as deep; nostril directed dorsolaterally, in the upper part of nasal; nasal divided by a cleft into anterior and posterior parts below nostril, surrounded by the first three or four supralabials ventrally, rostral anteriorly, internasal dorsally, prefrontal and loreal posteriorly on both sides; two internasals crescent-shaped, approximately twice as long as broad, in contact with rostral anteriorly; a single frontal, length equal to width, near triangular and tapering posteriorly; one pair of parietals, approximately 1.3 times longer than the frontal; a single loreal not enter the eye, in contact with third–fourth or third–fifth supralabials ventrally, upper preocular posteriorly, nasal anteriorly, a prefrontal dorsally, and not in contact with internasal on both sides; usually two preoculars, the lower one much small, rarely single one; usually two postoculars, lower one much small, rarely single one; 10 supralabials, the fifth and sixth or the sixth and seventh supralabials enter the eye; 9–11 infralabials, the first one touching each other behind the mental; two pairs of chin shields, anterior pair of chin shields large, approximately 1.2 times longer than posterior pair; the anterior pair of chin shields in contact with the first four or five infralabials on both sides; 1+1 or 1+2 temporal scales, temporal region smooth; dorsal scales moderately keeled throughout, in 23:23:21 or 23:23:23 rows; ventrals smooth, 170–176 in males, 157–159 in females, anal divided; subcaudals paired, 59–61 in males, 56–58 in females.

3.2 Coloration Dorsal surface dark olive with 37–44 complete or incomplete light yellow crossbars edged with black (27–33 at dorsal body, 7–14 at dorsal tail), see Table 2; the outer two scale rows light yellow; upper part of the most outer third scale row dark olive, lower part light yellow; ventral surface light yellow, ventral surface of head and tail mottled with blackish grey (Figure 2).

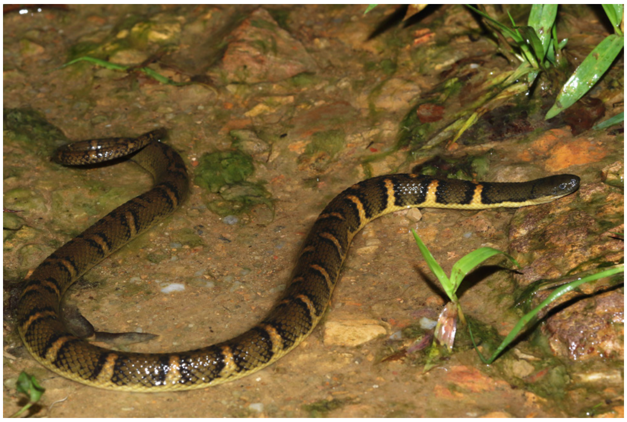

Figure 2 General aspect in life of *Opisthotropis laui* (female SYS r001622).

3.3 Variation Measurements, scalation and body proportions of newly collected specimens and holotype of *O. laui* are given in Table 1. The morphological characters of the six newly added specimens basically match the original description (Yang *et al.*, 2013), except that: dorsal scales moderately keeled throughout (*vs.* weakly keeled in holotype), anterior dorsal scale in 23 rows in all six specimens, posterior dorsal scale in 21 rows in three specimens (*vs.* 25:23:23 in the holotype; see Table 1); nasal divided by a cleft below nostril in four added specimens; the frontal divided into two in SYS r001061 (Figure 3 A); usually the sixth and seventh supralabials

Table 1 Measurements and scale counts of *Opisthotropis laui* specimens from this study.

	KIZ 60100	SYS r 1069	SYS r 1622	SYS r 1061	SYS r 1070	SYS r 1071	SYS r 1623
Sex	Female	Female	Female	Male	Male	Male	Male
TL	298.7	442.8	497.9	387.0	411.1	410.2	459.3
SVL	241.8	349.6	391.4	312.0	331.2	329.5	371.8
TaL	56.9	93.3	106.5	75.0	79.9	80.6	87.5
TaL/TL	19%	21.1 %	21.4%	19.4 %	19.4 %	19.7 %	19.1%
SE	/	4.1	4.7	3.6	3.7	3.6	4.1
HW	/	9.9	10	7.9	9.4	9.4	8.08
HL	/	14.9	16.2	13.4	13.2	13.1	14.5
ED	/	1.6	1.7	1.2	1.3	1.4	1.4
ED/HL	/	10.7%	10.5%	9.0%	9.8%	10.7%	9.6%
DSR (Sq1:Sq2:Sq3)	25:23:23	23:23:23	23:23:23	23:23:21	23:23:21	23:23:21	23:23:23
V	152	157	159	170	176	170	174
Sc	53	56	61	60	61	59	58
SpL	5–1–4/4–2–4	4–2–4/5–2–3	5–1–4/5–1–4	5–2–3/5–2–3	5–2–3/4–2–4	5–2–3/4–3–3	5–1–4/5–1–4
IfL	11/11	11/11	10/9	10/10	10/9	10/10	10/11
Temporals	1+2/1+2	1+2/1+2	1+2/1+2	1+2/2+2	1+2/1+2	1+1/1+1	1+2/1+2
Preocular	2/1	2/2	2/2	2/2	1/2	2/2	2/2
Postocular	2/2	2/2	3/3	2/2	2/2	2/1	2/2
Loreal	1	1	1	1	1	1	1
IN	2	2	2	2	2	2	2

Table 2 Counts of the cross bars of the *O. laui* specimens from this study.

No.	Dorsal body	Dorsal tail
KIZ060100	28	14
SYS r001061	29	8
SYS r001069	27	11
SYS r001070	33	7
SYS r001071	28	10
SYS r001622	29	11
SYS r001623	30	14

entering the eye, rarely fifth and sixth, or fifth, sixth and seventh entering the eye; in SYS r001061, lower parts of sixth and seventh supralabials fused with each other on left side (Figure 3 B) (*vs.* only sixth entering the eye on the left side of head in holotype); 9–10 infralabials in SYS r001061, 1070 ,1071 and 1622 (*vs.* 11 infralabials in holotype); the anterior chin shields in contact with the first four infralabials on both sides (with the first five infralabials in holotype); ventrals 170–176 in four male specimens, 157–159 in two female specimens (vs. 152 in female holotype); 58–61 pairs of subcaudals in four male specimens, 56–61 in female specimens (vs. 53 in holotype).

3.4 Revision of diagnostic characters Dorsal scales weakly to moderately keeled throughout , in 23(25):23:23(21) rows; 10 supralabials; 9–11 infralabials; two internasals, longer than wide, not touching with the loreal; one loreal, not touching with the eye; one or two preoculars; two postoculars; one or two posterior temporal scales; 170–176 ventrals in males, 152–159 ventrals in females; 58–61 pairs of subcaudals in males, 53–61 in females; body and tail dark olive above, with light yellow cross bars. See Table 1 and 2 for the detailed morphological comparison of the holotype with newly added specimens.

3.5 Distribution, ecology and behavior Currently, *O. laui* occurs is known from three localities: the type

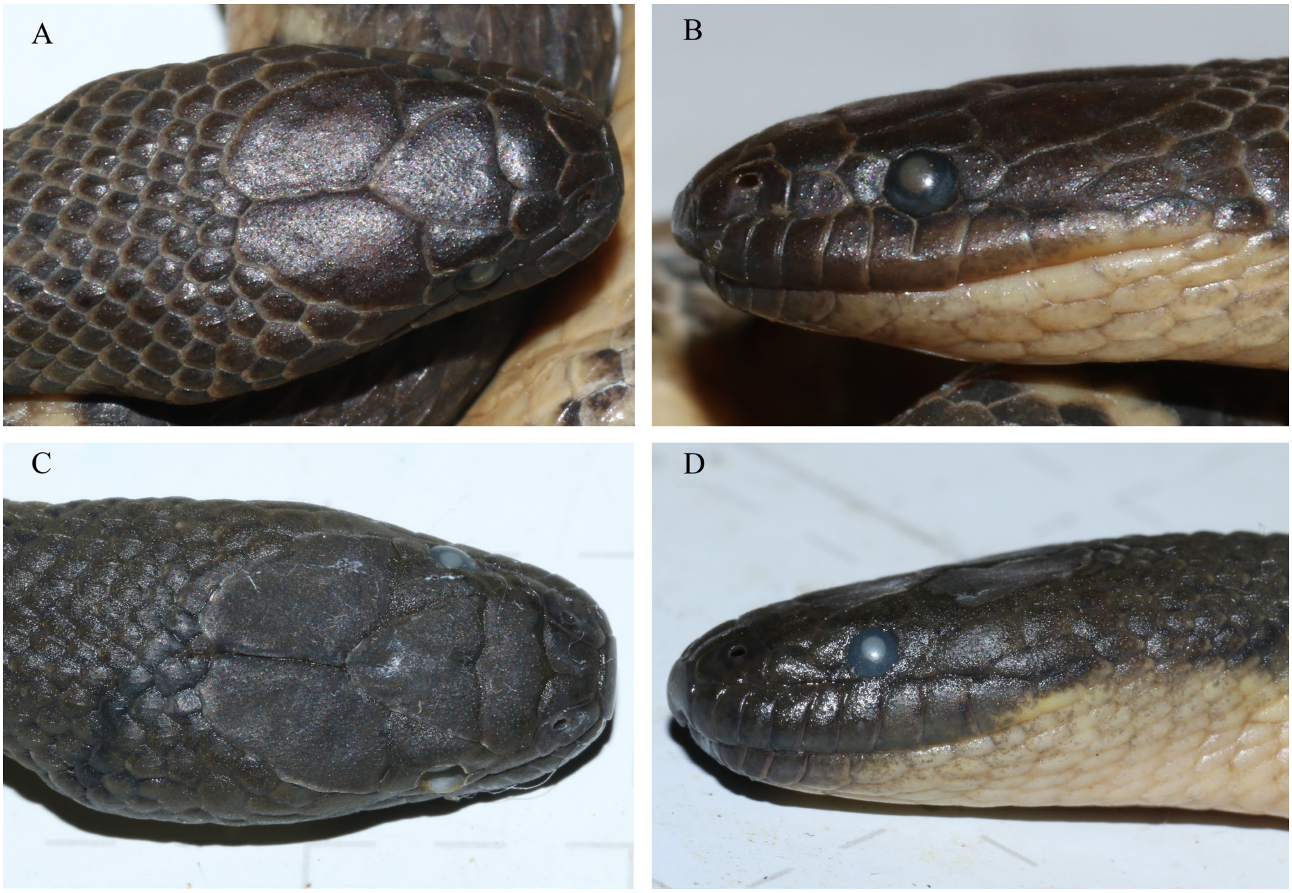

Figure 3 Variation of head scales: A and B, the prefrontal divided into two and the sixth and seventh supralabials fused in SYS r001061 from Shangchuan Island; C and D, intact head scales of SYS r001622 from Qixingkeng Natural Reserve.

locality, Beifengshan Forest Park in Mt. Gudou, Jiangmen City, and two new localities, Mt. Nianyu, Shangchuan Island, Taishan city and Qixingkeng Natural Reserve, Enping City of Guangdong Province, China (Figure 1). Four specimens from Mt. Nianyu were collected from an intermittent stream about 6 m wide covered with great rough rocks surrounded by secondary shrub forest at elevations between 108–130 m a.s.l.; the four individuals were discovered under crevices of huge rocks at night, and two of them were mating. The other two individuals from Qixingkeng Natural Reserve were collected in a perennial stream about 2 m wide which flowing slowly through deciduous broadleaved forest at the elevation of 230 m a.s.l.; the male individual was perching on the rock out of water surface, and the female one was swimming in the stream slowly when encountered, and both of them tried to escape when disturbed. They struggled fiercely when restrained in hand and had nauseating and pungent smell.

4. Discussion

Most members of *Opisthotropis* usually inhabit in flowing streams, where they are able to forage adequately and, more importantly, their scales are lubricated and protected by water. Similar to most aquatic vertebrates, if *Opisthotropis* snakes away from the water environment and are exposed to air for a long time, the scales derived from skin will be dehydrated, and then wrinkled, edge rolled, and become fragile (personal observation). On Shangchuan Island, the hills are precipitous and the streams usually cutoff seasonally, which exposing the huge rough rocks. *O. laui* individuals from here intermittent steep streams, would be forced to adapt crawling on the irregular rocks, that resulted in its scales especially the ones on the unkeeled head, being frayed and broken. Contrarily, the streams in Qixingkeng Natural Reserve are perennial and flow slowly, from where the snakes are living in changeless habitats whose scales are not easily broken.

The rediscovery of the Lau's stream snake, *O. laui*, further highlight the lack of field surveys in the coastal region of southern Guangdong province. However, these areas are now under the threats of habitat degradation due to land use changes. Since *Opisthotropis laui* seems to be only restrict to a small coastal area, further research should be carried out to investigate the population status and distribution of this species; and relevant conservation actions are needed to protect this endemic snake to China.

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